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A CORRODED LUMP THAT MODELED THE SKY

A LUMP FROM THE SEAFLOOR

In 1900 a crew of sponge divers from Symi, sheltering from weather in the lee of ANTIKYTHERA, a small island between Crete and the Peloponnese, worked roughly 45 meters down and found a Roman-era wreck strewn with bronze and marble statuary. Among the crates hauled to Athens was a SHAPELESS green mass, its surface bloomed into brittle mineral crust - the CORROSION that seawater builds on bronze across two thousand years. Two years later the ARCHAEOLOGIST Valerios Stais looked more closely and saw, inside the lump, the unmistakable rim of a toothed wheel.

SPELL Spell: **ARCHAEOLOGIST**

ARCHAEOLOGIST

SPELL Spell: **SHAPELESS**

SHAPELESS

KNOWN What is the name of the small island between Crete and the Peloponnese where the sponge divers sheltered from the weather?

ANTIKYTHERA

KNOWN What is the term for the brittle mineral crust that seawater builds on bronze over centuries?

CORROSION

OPEN Stais saw a toothed wheel inside a lump everyone else had taken for debris. What is something you noticed that everyone else had walked past?

Open response - use practitioner judgment

MATH The Antikythera ship is thought to have sunk around 60 BCE. How many years did it sit on the seafloor before the divers found the wreck in 1900?

1960

INSIDE THE BRONZE MACHINE

The wheel belonged to a bronze machine the size of a shoebox, driven by a hand crank that turned a CROWN gear - teeth standing perpendicular to its face, passing motion around a right angle. Some thirty surviving gearwheels, their triangular teeth cut by hand, split that input into ratios. On the front, pointers carried the sun and the moon around a ZODIAC ring of twelve signs, and a half-silvered sphere turned to show the lunar phase. A pin riding in a slot, mounted on EPICYCLIC gearing - gears carried on a moving platform rather than a fixed axle - made the moon pointer hurry and lag, reproducing the lunar ANOMALY, the moon's uneven pace against the stars.

SPELL Spell: ZODIAC

ZODIAC

SPELL Spell: CROWN

CROWN

KNOWN What is the term for the moon's uneven pace against the stars, running fast at some points and slow at others?

ANOMALY

KNOWN What is gearing called when the gears ride on a moving platform rather than a fixed axle?

EPICYCLIC

OPEN Every one of those thirty gears was cut by hand with triangular teeth. What would you make by hand if you had the patience?

Open response - use practitioner judgment

MATH A zodiac ring divides a full circle of 360 degrees into twelve equal signs. How many degrees does the sun pointer travel to cross one sign?

30

THE BACK SPIRALS

The back plate held the calendar logic as two spirals. The upper, five turns divided into 235 cells, ran the METONIC cycle: 19 solar years equal almost exactly 235 SYNODIC months, a synodic month being one complete round of lunar phases. A subsidiary pointer tracked the 76-year CALLIPPIC cycle, four Metonic periods long. The lower spiral, four turns of 223 cells, ran the SAROS, the interval after which sun and moon return to nearly the same alignment; GLYPHS in its cells gave the hour of a predicted ECLIPSE. A small EXELIGMOS dial supplied the hours to add after three Saros cycles, 54 years.

SPELL Spell: ECLIPSE

ECLIPSE

SPELL Spell: GLYPHS

GLYPHS

KNOWN What is a month called when it is measured as one complete round of lunar phases?

SYNODIC

SEMI_OPEN Name two of the astronomical cycles the back dials count out.

NEEDS 2 OF METONIC / CALLIPPIC / SAROS / EXELIGMOS

OPEN The dial names the hour of an eclipse years before it happens. What would you want to know years in advance?

Open response - use practitioner judgment

MATH The Callippic cycle runs 76 years and is exactly four Metonic cycles long. How many years long is one Metonic cycle?

19

READING THROUGH THE CRUST

None of it could be read for most of a century, because the corrosion that preserved the gears also sealed them. Derek de Solla Price and a Greek RADIOGRAPHER counted teeth through the crust with gamma rays in the 1970s; in the 2000s microfocus computed TOMOGRAPHY - reconstructing a solid object as a stack of X-ray slices - together with raking-light surface imaging recovered thousands of characters of inscription no eye had ever seen. The month names on the Metonic spiral turned out to belong to the CORINTHIAN calendar rather than the Athenian one, and a small games dial named four festivals: Isthmia, Olympia, Nemea and Pythia.

SPELL Spell: CORINTHIAN

CORINTHIAN

SPELL Spell: RADIOGRAPHER

RADIOGRAPHER

KNOWN What is the technique called that reconstructs a solid object as a stack of X-ray slices?

TOMOGRAPHY

OPEN Thousands of characters no eye had ever seen came back into view once the crust was scanned. What would you expect is still hidden inside the gears?

Open response - use practitioner judgment

THE MISSING PLANETS

What the machine does not settle is how much of the sky it showed. Reconstructions propose gear trains for the five planets visible to the naked eye - MERCURY, VENUS, MARS, JUPITER and SATURN - using epicyclic arrangements to mimic RETROGRADE motion, the apparent backward drift of a planet against the stars. But no PLANETARY gearing survives among the 82 known fragments. Its GEOCENTRIC model, with Earth fixed at the center, meant the ratios approximated appearances rather than orbits. Dating divides scholars as well: the cargo points to the first century BC, while some readings of the dials argue for an earlier build.

SPELL Spell: GEOCENTRIC

GEOCENTRIC

SPELL Spell: PLANETARY

PLANETARY

KNOWN What is the apparent backward drift of a planet against the stars called?

RETROGRADE

SEMI_OPEN Name two of the five naked-eye planets the reconstructions try to account for.

NEEDS 2 OF **MERCURY / VENUS / MARS / JUPITER / SATURN**

OPEN If one more fragment of the machine were pulled from the wreck, what would you want it to show?

Open response - use practitioner judgment

STILL KEEPING TIME

You already live with the problem this machine was built to solve. Your calendar year and the moon's phases do not divide evenly, so any lunar-solar reckoning needs INTERCALATION - inserting an extra month or day to keep the count honest - which is exactly what the 19-year Metonic spiral automated. If you wear a mechanical watch with a moon-phase display, its maker calls that a COMPLICATION: a function added beyond telling the hour, driven by gears whose tooth counts encode an ASTRONOMICAL ratio, just as the Antikythera gears did. And the lump itself is worth remembering the next time something looks like debris rather than information.

SPELL Spell: **COMPLICATION**

COMPLICATION

SPELL Spell: **ASTRONOMICAL**

ASTRONOMICAL

KNOWN What is the name for inserting an extra month or day into a calendar so the lunar count stays honest against the solar year?

INTERCALATION

OPEN A moon-phase display is one function a watchmaker adds beyond telling the hour. What extra function would you want a watch of your own to track?

Open response - use practitioner judgment

MATH A 19-year Metonic cycle contains 235 lunar months, while nineteen years of twelve ordinary months come to only 228. How many extra months are intercalated across one full cycle?

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